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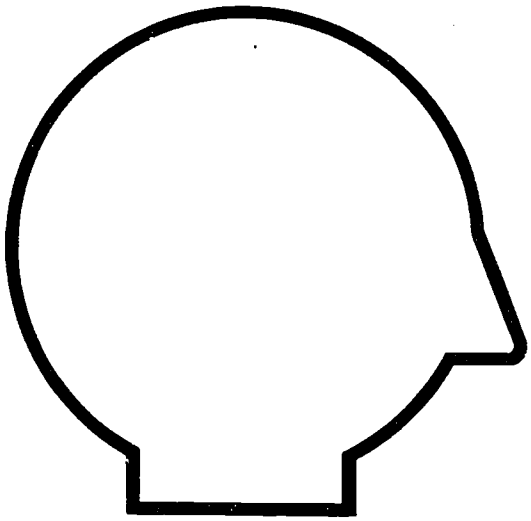
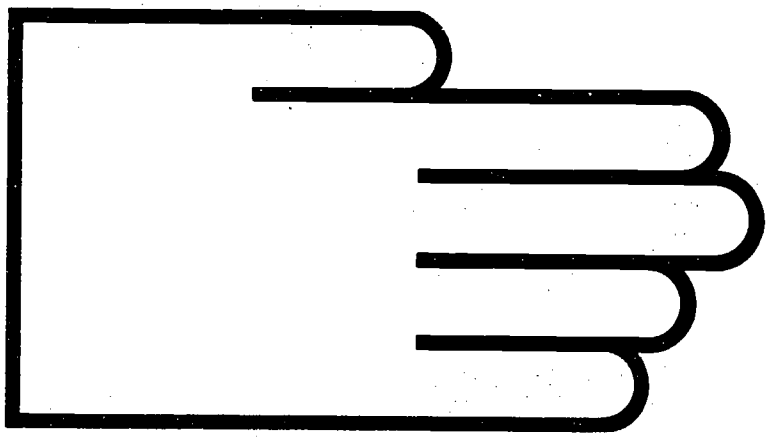
ABSTRACT

This module, one of 25 on vocational education training for careers in environmental health occupations, contains self-instructional materials on operating sound-measuring equipment. Following guidelines for students and instructors and an introduction that explains what the student will learn are three lessons: (1) selecting decibel ranges, checking the conditions of batteries, and measuring sound levels; (2) testing decibel level response and using a sound level calibrator; and (3) screening survey measurements. Each lesson contains objectives, recommended methods and locations for practice, performance criteria, equipment and supplies to perform a task, detailed step-by-step instructions for learning a task, and performance exercises. Two performance tests cover calibrating exercises the general-purpose sound level meter and making screening survey measurements. (CT)



Operating Sound-Measuring Equipment



Module 1

U.S. DEPARTMENT OF EDUCATION, Office of Vocational and Adult Education

FOREWORD

The Curriculum and Instruction Branch of the Office of Vocational and Adult Education, U.S. Department of Education, identified a need to improve the training opportunities for vocational education students interested in pursuing careers in environmental health. To fulfill that need, Consumer Dynamics, Inc., a Rockville, Maryland, based company, was awarded the contract to develop performance-oriented, competency-based modules in the environmental health sciences.

OPERATING SOUND MEASURING EQUIPMENT is one of the modules in the series, "Vocational Education Training in Environmental Health Sciences." The module content is based on selected texts and other materials in the environmental health field. The module is intended to supplement existing course materials.

CONTENTS

USING THESE SELF-INSTRUCTION MATERIALS

This self-instruction learning package or module is designed to allow students and instructors flexibility of use. Although primarily intended for use in existing training programs, the modules may be used by anyone interested in learning new skills or perking up old ones. Therefore, two sets of guidelines are presented: one set addressed to students and the other set addressed to instructors. First, find out how you, the student, should use the materials in this book.

GUIDELINES FOR STUDENTS

Take the Performance Test as a pretest.

When you pick up this book and work through it, your goal will not be a letter grade or a high score on an exam. Instead, you will work to develop skills that you can measure. You will not have to worry about how well someone else is doing. Before you start work on this book, you should, first, find out if you have sufficient skills to start training by reading through the section called PERFORMANCE TEST. If you think you can do all or most of the items in the test, ask your instructor to obtain the necessary equipment and supplies. Although you do not need special preparation in mathematics or physics to calibrate and operate a sound level meter, you should have some working knowledge of science. You do not have to have specialized skills to enter training in this module.

Work on parts you need to practice.

If you do everything well, according to the criteria in the Performance Test guidelines, you will not need to spend time working on this module. If after taking the Performance Test you discover there are parts you need to practice, follow the key to each item in FOR FURTHER STUDY.

USING THESE SELF-INSTRUCTION MATERIALS

Work straight through each lesson in the order presented.

Should you decide to completely work through this book, begin with the INTRODUCTION and go straight through each of the three lessons. The lesson begins with the OBJECTIVE of the training. Follow the instruction for each part in the order presented. Practice each step in a lesson until you can do it according to the criteria stated for the step. At the end of a lesson, do the EXERCISES. When there are audiovisuals listed at the end of a lesson, ask your instructor for help in obtaining them.

Take the Performance Test as a posttest.

Finally, after you have mastered all of the exercises in each lesson, ask your instructor to watch you calibrate and operate a sound level meter. The items in the Performance Test are intended for use as a posttest to evaluate the quality of your performance. Turn now to the Performance Test.

GUIDELINES FOR INSTRUCTORS

Approach

The approach of these materials is to provide the student with a set of procedures for calibrating and operating a Type 2 sound level meter. If the meters you use to teach the procedures are a different make and model from the meter in this module, you may need to write supplementary instructions to point out the differences. The items in the Performance Test are designed for use with any make and model of Type 2 sound level meter.

Independent Study

Students can work independently and at their own pace. Depending on the time frame you set for completing each lesson, you may want to start a group off in each lesson with a demonstration and informal presentation.

As a Laboratory Workbook

Alternatively, you may choose to use this module as a laboratory workbook in a structural laboratory session. With this option, you may allow students greater access to your assistance, especially in watching them perform the pre- and posttest portions of the training.

USING THESE SELF-INSTRUCTION MATERIALS

General Instructions	Read through each lesson to anticipate what equipment and supplies you will need to make available for students to use. Also, order any audio-visuals or reading materials you think may present a complementary perspective to the training in this module. Use the items in the Performance Test as the minimum requirements for gauging successful completion of training.
Specific Instructions	Advise students to carry appropriate hearing protection devices, including earplugs and muffs, on entering a potentially noise-hazardous area, and to wear them when the level is equal to or greater than 85 dBA.

BACKGROUND

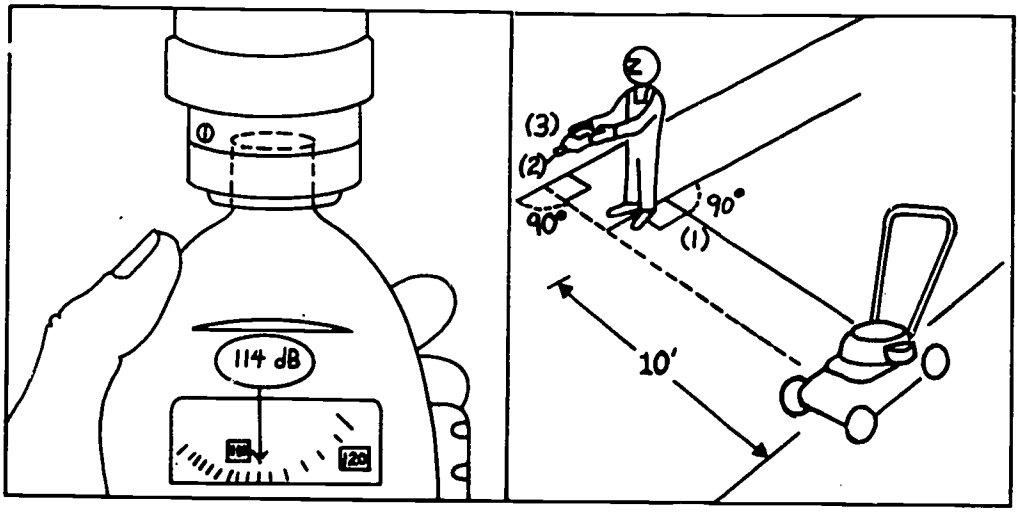
Sounds of all kinds are associated with nearly every aspect of life and living in the modern world. They are a part of travel, work, and recreation. But sound becomes a problem to human health when it is too loud and too intense. Increasing levels of unwanted sound (noise) and its harmful effect on workers and the general public is a growing concern to everyone. In efforts to control harmful levels of noise in the workplace at the Federal level, the Occupational Safety and Health Administration is working with labor, industry, and government. To provide protection for the general public against hazardous levels of outside or environmental noise, the U.S. Environmental Protection Agency (EPA) is working with similar groups. EPA's targets for the control of environmental noise include motor vehicles, airplanes, railroads, and industrial and commercial plants. No matter who is trying to control hazardous noise, one of the first steps toward controlling excessive noise is finding out if noise from one source or another may be hazardous.

Sound levels are measured by the use of several types of electronic equipment. The way they work is basically the same. The major differences among them lie in how the physical sound wave energy is converted into electrical energy. Electronically sophisticated meters are sensitive to sound levels at different frequencies. These meters are used to do detailed noise studies. Less electronically sophisticated meters detect sound levels for all frequencies at the same time. Readings made with these general-purpose meters are used to indicate if a noise problem may exist. This is the type of meter you will most frequently use. Other types of instruments are used to measure impact noise and vibration. Readings you record will be used to determine if a more detailed noise study should be done. Therefore, these kinds of measurements make up what is known as a screening survey.

You may be required to take screening survey measurements, using a general-purpose Type 2 (ANSI S1.4-1971 Type 2) sound level meter (SLM), if you are employed in any one of a number of industries or government agencies. Although you will be instructed in the use of one particular make and model of SLM, the calibrating and operating procedures are basically the same for using other SLM's.

WHAT YOU WILL LEARN

When you finish working through the steps and exercises in this module, you will be able to calibrate, operate, and position a Type 2 sound level meter (SLM) for taking accurate screening survey measurements.



Using a Type 2 SLM, you will learn how to perform these functions in three lessons:

- Lesson One

  You will be able to select decibel ranges, check the condition of batteries, and set the SLM's response for measuring sound levels.

- Lesson Two

  You will be able to test the SLM's decibel level response at the standard calibrating frequency, 1000 hertz (Hz), using a sound level calibrator as the calibration source.

- Lesson Three

  You will be able to make screening survey measurements, using a gasoline-powered lawnmower as a noise source.

LESSON ONE

OBJECTIVE

You will be able to select decibel ranges, check the condition of batteries, and set the SLM's response for measuring sound levels.

WHERE AND HOW TO PRACTICE

You can practice this lesson almost anywhere you can find a clean tabletop. Before working through this book, read the manufacturer's operating instructions manual. Read through each step before working on it. If you have any questions about anything in the lesson, ask your instructor or supervisor for help. When you think you know the parts of the SLM and how they work, practice labeling the drawings in the exercises. To help learn the functions of each part, tape-record a description of each in your own words. Play back the descriptions and match them with the descriptions in the lesson.

HOW WELL YOU MUST DO

You must be able to accurately name all parts of the SLM and describe how they work.

THINGS YOU NEED

You will need the following equipment:

- o general-purpose SLM, Type 2, General Radio Model 1565B or equivalent*
- o batteries (2), 9V, Burgess 2U6 or equivalent*
- o manufacturer's operating instructions manual.

Instructions: Now turn to the next page and begin work on Lesson One, "Getting There--Steps."

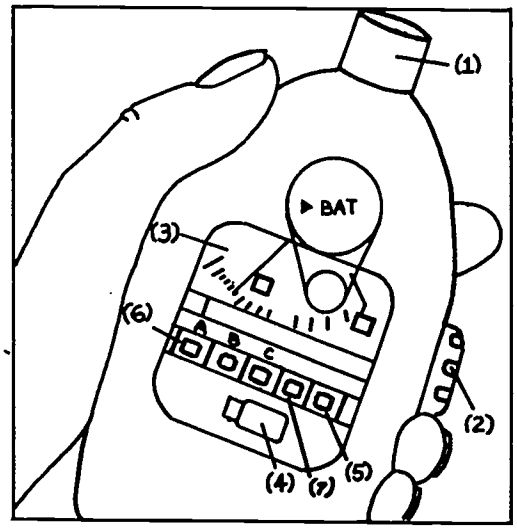
*Use of these brand names is not intended to be an endorsement by the Department of Education for any particular product or product line. The equipment shown in this book was selected because it is widely available and commonly used.

GETTING THERE--STEPS

STEP 1

Holding an SLM in front of you, identify the main components: (1) the microphone to convert physical sound waves into electrical impulses; (2) the decibel (dB) range selector; (3) the meter for indicating the sound level in dB's and battery condition; (4) the "ON" slide switch; (5) the battery check button; (7) the response switch (slow) for changing the detector's electronic sensitivity; and (6) the weighting network with three selector buttons for adjusting the SLM's electronic circuitry to give a reading comparable to what the human ear hears. The weighting network "A" mimics the ear's response to low intensity sounds. Sound level measurements obtained using the "A" network are recorded in dBA's.

KEY POINT 1

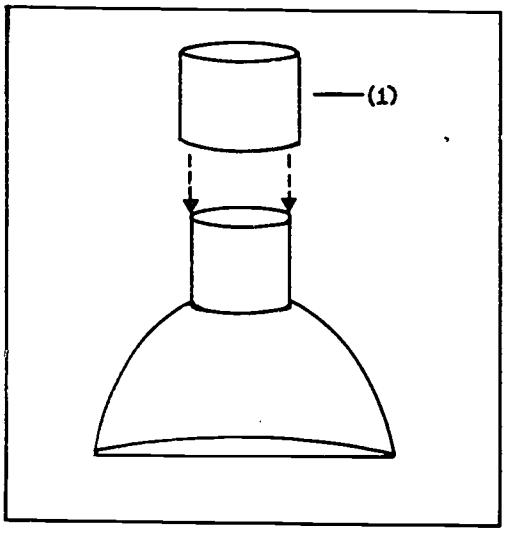


The main components are basically the same from one SLM to another.

STEP 2

Pick up the SLM and remove the plastic dust cap (1) from the microphone. If you do not remove the protective dust cap, the readings may be less than they should be. The GR1565 SLM used in this lesson has a ceramic crystal microphone. This type is commonly used because it is not sensitive to magnetic fields, can withstand operating temperatures from -10° C (14° F) to 50° C (122° F), and can be operated in relative humidity up to 90 percent. Because the SLM is a precision instrument, check the instrument operating manual for any limitations or precautions for its use.

KEY POINT 2

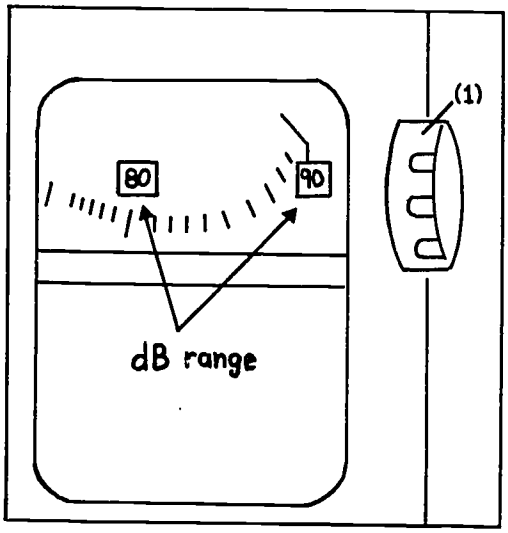


The ceramic crystal microphone is one of the most widely used types in SLM's.

STEP 3

Hold the SLM in your left hand. The large knob on the right side of the instrument is the range selector (1). Watching the numbers in the two small windows in the meter face, turn the knob with your right hand.* The eight-position rotary switch selects the operating dB range of the SLM. Note that the meter scale has 10 marks between the selected decibel range numbers in the small windows. Each mark, therefore, is 1 dB.

KEY POINT 3



The range selector sets the operating range of the SLM in increases of 10 dB's.

*If the range selector switch does not turn, it may be locked. Locate the locking device under the range dial and push it down away from the dial.

STEP 4

Find the words "Battery OK" (or BAT) on the upper right part of the meter dial. Push the "ON" slide bar to the right and push the battery check button and hold it until the meter needle settles. If the batteries are fully charged, the meter needle will rest at a point over the words "Battery OK" (or BAT). If the batteries need to be replaced, turn the meter off. Turn the meter over and remove the battery housing cover near the bottom of the instrument case. Refer to the operating instructions if you have any question about replacing the batteries or checking their condition. After testing the new batteries, turn the meter off.

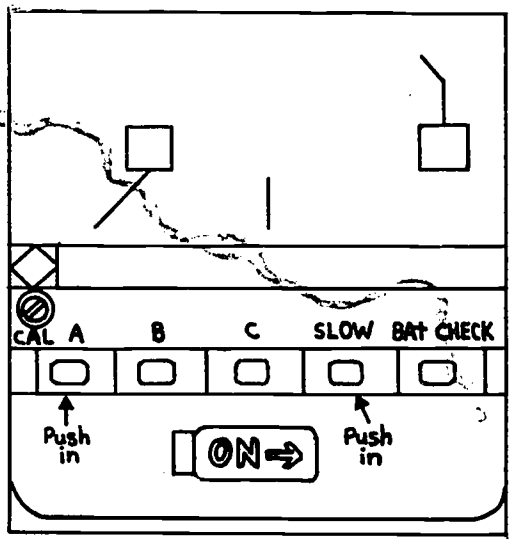
KEY POINT 4

Check the condition of the batteries before making any measurements or checking out other meter functions.

STEP 5

Push in the "Slow" button. When a noise source is present, the meter needle will move slowly in response to repeated small changes in sound level. Next to the "Slow" button are the weighting network buttons, A, B, and C. Push in the "A" button. Screening surveys are usually done with "Slow" and "A" buttons pushed in.

KEY POINT 5

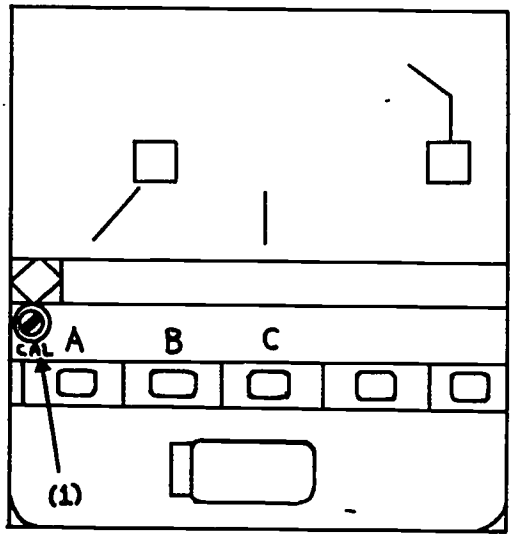


For making most screening survey measurements, the "Slow" and "A" buttons are pushed in.

STEP 6

Find the calibration adjustment screw (1) located in a recessed area slightly above and to the left of the "A" button. As part of Lesson Two you may need to adjust the meter so that it reads 114 dB when calibrated with the sound level calibrator.

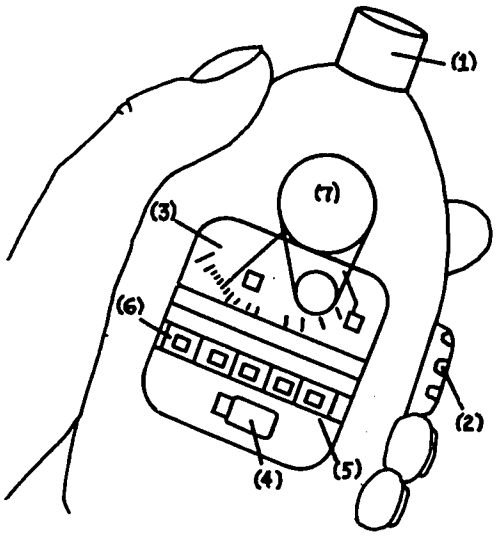
KEY POINT 6

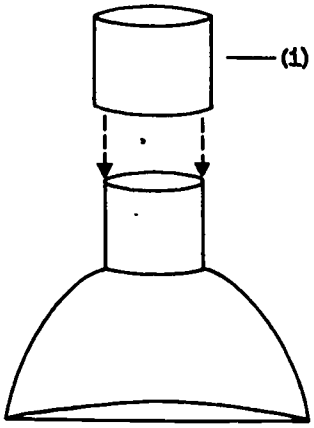


Use a small-blade screwdriver to turn the calibration screws.

EXERCISES

Instruction 1: Referring to the equipment and/or drawings in the lesson, label the following drawings. You must be able to name each part or label in the drawing and describe in your own words how a part works or what a label means.





(1) _____

(2) _____

(3) _____

(4) _____

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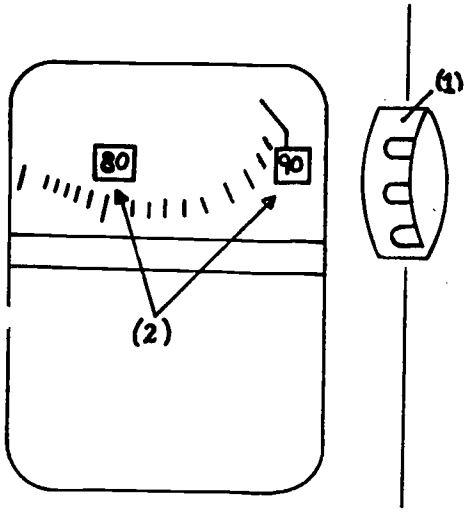
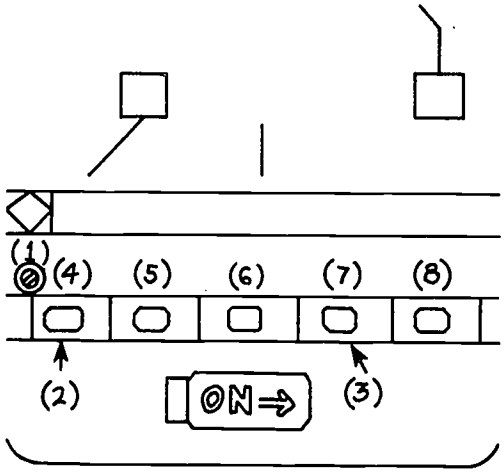
(6) _____

(7) _____

(1) _____





(1) _____

(2) _____

(1) _____

(2) _____

(3) _____

(4) _____

(5) _____

(6) _____

(7) _____

(8) _____

Instruction 2: When you can correctly label each part in this exercise and can tell what it does without referring to this book or to the manufacturer's operating instructions manual, begin work on Lesson Two.

LESSON TWO

OBJECTIVE

You will be able to test the SLM's decibel level response at the standard calibrating frequency, 1000 Hz, using a sound level calibrator as the calibration source.

WHERE AND HOW TO PRACTICE

Because the SLM is sensitive to surrounding sound levels when the calibrator is used, you must practice this lesson in a quiet room. Read through each step before working on it. Ask your instructor or supervisor for help if needed. Follow the instructions in Exercises. Make sure you can do the steps and exercises before going on to Lesson Three.

HOW WELL YOU MUST DO

You must be able to calibrate the SLM with a 1000-Hz calibrator so that the SLM reads exactly 114 dB at a frequency of 1000 Hz. (The SLM and calibrator must be in normal operating condition.)

THINGS YOU NEED

In addition to the equipment you used in Lesson One, you will need the following:

- o sound level generator capable of generating 114 dB at a frequency of 1000 Hz, General Radio Model 1562A or equivalent*
- o replacement battery, 9V, Burgess PM6* or equivalent
- o screwdriver, 1/8-inch-wide blade, jewelers.

Instructions: Now turn to the next page and begin work on Lesson Two, "Getting There--Steps."

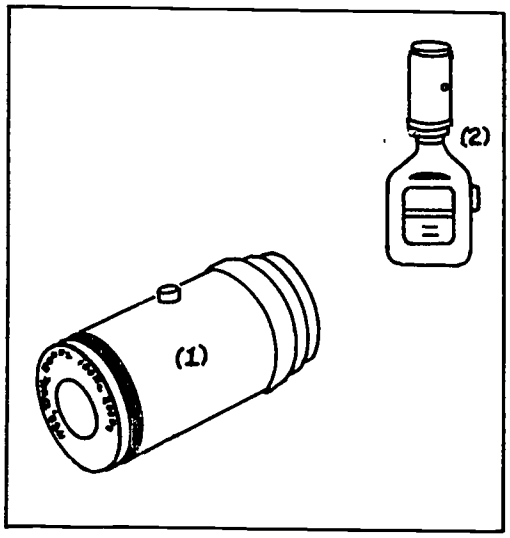
*Use of these brand names is not intended to be an endorsement by the Department of Education for any particular product or product line. The equipment shown in this book was selected because it is widely available and commonly used.

GETTING THERE--STEPS

STEP 1

Obtain a sound level calibrator. The SLM can be calibrated with a single or multiple frequency sound generator (1). The sound level calibrator, GR 1562A, which accompanies the GR 1565B SLM, is a multiple frequency sound generator. It enables testing of frequency response as well as testing at the standard sound level of 1000 Hz. The calibrator produces an audible tone of 114 dB at each of five frequencies. The calibrator fits over the microphone on the SLM (2). Check that the calibrator has the proper size adaptor for the microphone on your SLM.

KEY POINT 1

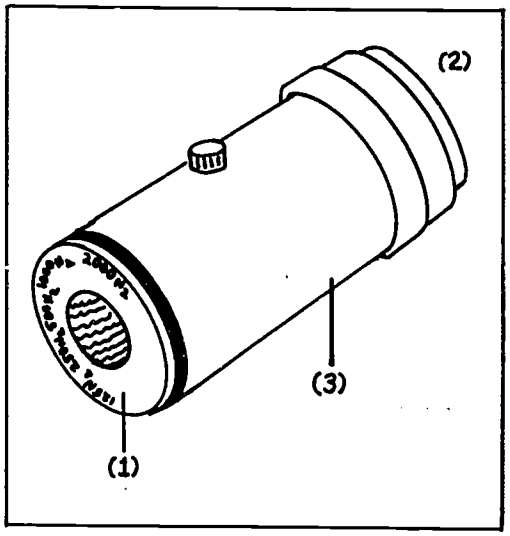


The sound level calibrator can be a single or multiple frequency generator.

STEP 2

Identify the parts of the sound level calibrator and their functions. The sound level calibrator for the GR1565B consists of (1) an ON-OFF switch and frequency selector switch that is all one unit; (2) a fitting and housing into which the SLM microphone is inserted for calibration; and (3) a removable cylindrical jacket for easy replacement of the battery.

KEY POINT 2



Although the functions of sound level calibrators are similar, placement of controls and operation often differ among manufacturers.

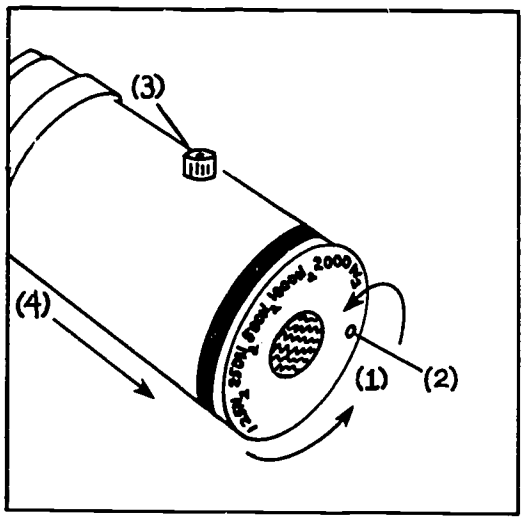
STEP 3

Before beginning the calibration procedure, check the condition of the calibrator's battery. First, turn the dial counterclockwise (1) and hold the dial in this position for a few seconds. If the battery is fully charged, the indicator light will come on (2). To change the battery, remove the large thumbscrew (3) from the calibrator cover, and slip the cover (4) off the end of the instrument. Do not overtighten the thumbscrew when replacing the cover. Check the new battery as you did in this step.

STEP 4

Switch on the SLM. Check the battery condition as a routine step. Set the range switch to the 110- 120 dB range. Press the "Slow" button. Press the "A" weighting network button. The SLM is ready for calibration.

KEY POINT 3



When the calibrator meter indicator light is on, the battery is in operating condition.

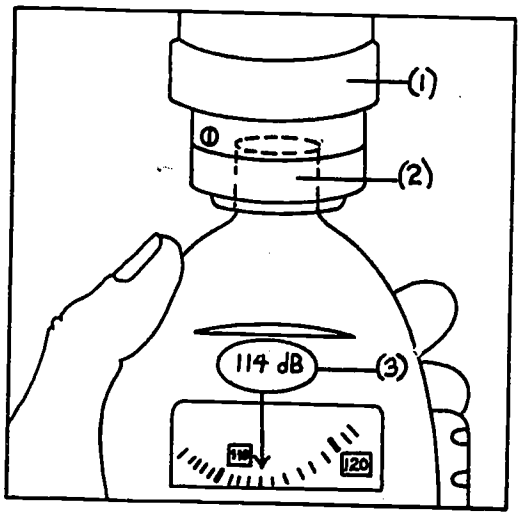
KEY POINT 4

To get the SLM ready to calibrate, check the battery, select the 110-120 dB range, and press the "Slow" and "A" buttons.

STEP 5

Hold the SLM in a vertical position with one hand. Pick up the calibrator (1) and position it over the microphone (2). Slowly push the calibrator onto the microphone as far as it will go. The calibrator will be secure enough to release your grip on it. Turn the calibrator dial counterclockwise all the way to the battery test position before turning the dial to the 1000 Hz setting. This prevents possible damage of the circuitry. Read 114 dB ±1 dB (3) on the SLM meter scale. Place the jeweler's screwdriver blade into the groove of the "Cal" setscrew. Turn it clockwise if the reading needs to be increased or turn it counterclockwise if it is too high.

KEY POINT 5



Adjust the "Cal" setscrew to make the meter needle read exactly 114 dB.

STEP 6

If you are not going to use the SLM or the calibrator the rest of the day, remove the batteries from both instruments. Make it a routine practice never to store the SLM or the calibrator with the batteries inside the instruments.

KEY POINT 6

Remove all batteries before even temporary storage of the instruments.

EXERCISES

Instruction 1: Practice each step in Lesson Two until you can do the following:

1. Check the battery of the sound level calibrator and replace it if it is exhausted.

2. Select the correct decibel range and meter response for calibrating the SLM.

3. Obtain a reading of 114 dB with the SLM while operating the calibrator at 1000 Hz; a frequency of 1000 Hz is commonly used because noise containing concentrated energy at octave bands 600-1200 Hz and above is more hazardous than at lower frequencies.

Instruction 2: When you can perform each of the above correctly without referring to this book or to the manufacturer's operating instructions manual, begin work on Lesson Three.

LESSON THREE

OBJECTIVE

You will be able to make screening survey measurements, using a gasoline-powered lawnmower as a noise source.

WHERE AND HOW TO PRACTICE

You will need to practice this lesson on a rainless day in a level area measuring at least 25 feet by 25 feet. The noise source (lawnmower) should be placed in the center of the area. Read through each step before you try one. Then, take measurements the way they are described in "Getting There--Steps."

HOW WELL YOU MUST DO

You must be able to perform each step without assistance and without referring to this book. You must be able to read the meter to within $\pm$0.5 dB.

THINGS YOU NEED

In addition to the equipment you used in the previous lessons, you will need:

- a windscreen for the SLM microphone
- a gasoline-powered lawnmower
- clipboard with paper and pencil
- measuring tape.

Instructions: Now turn to the next page and begin work on Lesson Three, "Getting There--Steps."

GETTING THERE--STEPS

STEP 1

Before making any measurements, check the SLM batteries and calibrate the SLM at 1000 Hz. If it has been a while since you completed the previous lessons in this book, repeat Steps 3, 4, and 5 in Lesson Two before working through the steps and exercises in this lesson. After repeating those steps, make sure the "Slow" and "A" buttons are pushed in. If, at some later time the measurement procedure you will be following requires a "Fast" meter response, leave the "Slow" button out. Before going to Step 2 of this lesson, however, slide the ON-OFF switch to the "OFF" position.

KEY POINT 1

Check the battery condition and calibrate the SLM each time before making measurements.

STEP 2

Before you begin taking sound level measurements, you should have some idea how loud the noise source is. Some commonly known noise sources are listed in Key Point 2. If you do not know how the noise source you want to measure compares with any of these noise levels, try the 3-foot rule as described in Step 3 below.

KEY POINT 2

Over 85 dBA
- Diesel truck at 40 mph at 50 ft
- Gasoline-powered lawnmower at the operator's ear
- Disco band

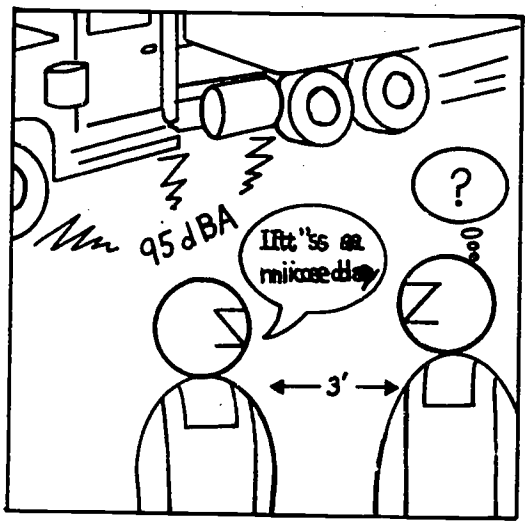
Between 55 and 85 dBA
- Air conditioner at 25 ft (60 dBA)
- Normal conversation at 3 ft (60 dBA)
- Vacuum cleaner (70 dBA)
- Garbage disposal at 3 ft (80 dBA)

Less than 55 dBA
- Quiet room

STEP 3

To test the 3-foot rule, try speaking to someone standing only 3 feet away. If you must shout to be heard, the sound level probably will be 90 dBA or greater. If this sound level exists in the area in which you will be working or taking measurements, be sure to wear earplugs or other hearing protection devices.

KEY POINT 3

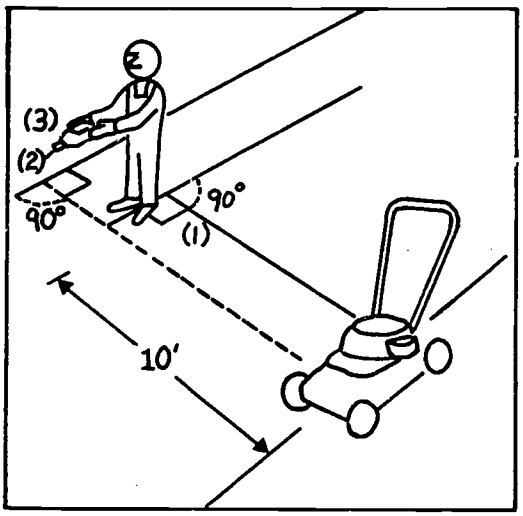


If you must shout to be heard by someone standing 3 feet away, the sound level is probably 90 dBA or greater.

STEP 4

Start up the lawnmower. Run it at full throttle. Walk a few feet away. Stand sideways at a 90° angle (1) from the lawnmower. Switch on the SLM. Hold the SLM straight out at a 90° angle (2) to the noise source with the meter face upward, level with the ground, and away from your body. Rotate the SLM's range selector switch to the highest range. Watch the needle. Select a lower range if the needle falls below the lowest number in the range. Read the needle to within ±0.5 dB when it is as close to the middle of the range as possible.

KEY POINT 4

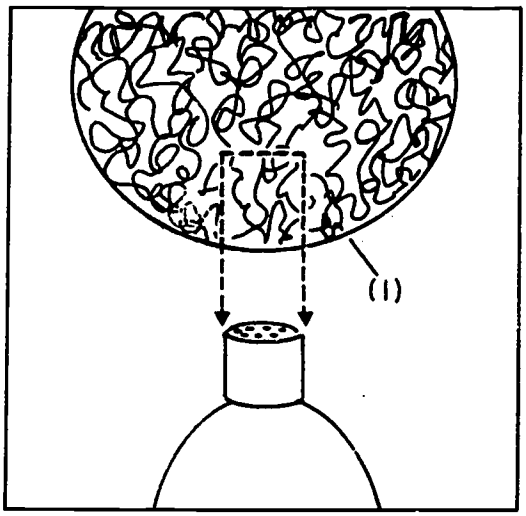


The microphone must be at a 90° angle to the noise source, and at the side of the person taking the readings--not between the person and the noise source.

STEP 5

Air moving across the microphone creates additional background noise that prevents you from making accurate measurements. If the wind is blowing hard enough to make small tree limbs sway, place a windscreen (1) over the microphone before you take any measurements. The windscreen is a sphere-shaped piece of plastic foam that is supplied by SLM manufacturers; it reduces howling noise caused by the wind without affecting the readings.

KEY POINT 5

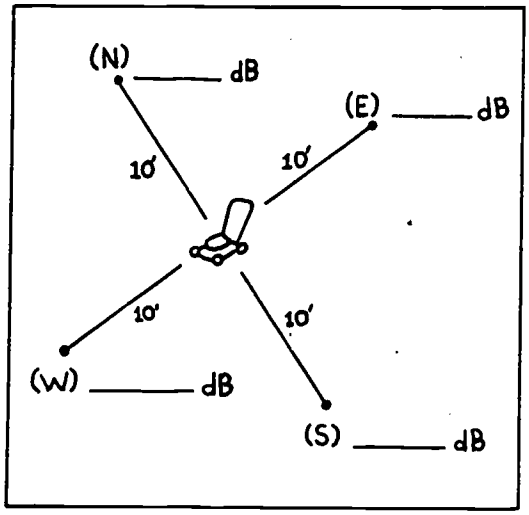


Use a windscreen when the wind is blowing.

STEP 6

Move the mower to a level open area. There should be no trees, boulders, or other obstacles around it for at least 10 feet. Staying within 10 feet of the mower, take measurements at each of the four points of the compass (N, E, S, W). Record the readings you get in the spaces provided in Key Point 6. These types of measurements are screening survey measurements taken quickly to determine if a more detailed noise survey should be done.

KEY POINT 6



Take several measurements that are on a clear path between the noise source and the SLM.

EXERCISES

Instruction 1: Practice each step in Lesson Three until you can do the following:

1. Demonstrate the 3-foot rule and describe how it is useful in obtaining screening survey measurements.

2. Stand sideways at a 90° angle to the noise source holding the SLM so the meter face is upward and level with the ground.

3. Read the decibel level within ±0.5 dBA; the meter needle should not lie outside the decibel range selected.

4. Describe when to use a windscreen.

5. Take measurements on a clear path between the meter and the noise source.

Instruction 2: Repeat Step 6 by taking readings at 5 feet and at 2 feet. Draw maps on which to record your measurements. Be sure to identify which reading was made at what distance.

Instruction 3: Move the mower behind a tree or large obstacle and repeat Step 6 by taking readings at 10 feet, at 5 feet, and at 2 feet. Compare these readings with the ones you recorded in Key Point 6.

Instruction 4: Repeat Step 6 using different noise sources. Draw maps for each noise source you measure. For example, use an electric-powered lawnmower instead of a gasoline-powered one. Compare the results.

Instruction 5: After you have completed these exercises and believe you are ready to demonstrate how to calibrate and operate a general-purpose SLM, ask your instructor or supervisor to evaluate your progress. Turn to the Performance Test for a review of what you must demonstrate.

FILMS AND SLIDE/TAPE PROGRAMS

U.S. National Bureau of Standards. "Noise Presentation," National Audiovisual Center, Washington, DC, 1972.

This 12-minute, 16-mm color film presents various sources of noise pollution that surround us. It shows how the noise levels range from quiet sounds to some that are extremely loud.

PERFORMANCE TEST

Instructions: Check your skill level or progress by working through each of the items in this test. If you can perform each item as required, place a check in the space provided. When all of the items are checked, you are ready to demonstrate your skills to your instructor. You may use the following list if needed. You will be considered trained in a skill after your instructor approves your performance of each of the following items:

CALIBRATING THE GENERAL-PURPOSE SOUND LEVEL METER

No. 1 ____ Check and replace the batteries in the sound level meter (SLM).

No. 2 ____ Select the appropriate decibel range for calibrating the SLM.

No. 3 ____ Adjust the weighting network response of the SLM for calibration.

No. 4 ____ Check and replace the battery in the sound level calibrator.

No. 5 ____ Turn the frequency selector dial of the multi-frequency calibrator to the calibrating frequency in a way that will prevent damage to the circuitry.

No. 6 ____ Adjust the SLM meter needle so that it reads exactly 114 dB when calibrated at 1000 Hz.

FOR FURTHER STUDY

If you could not perform one or more of the six items above, review and practice the following lesson steps:

No. 1
Lesson One, Step 4

No. 2
Lesson One, Step 3

No. 3
Lesson One, Step 5

No. 4
Lesson Two, Step 3

No. 5
Lesson Two, Step 5

No. 6
Lesson Two, Step 5

MAKING SCREENING SURVEY MEASUREMENTS

No. 1 ____ Hold the SLM away from your body and level with the ground at a 90° angle to the noise source.

No. 2 ____ Read the meter scale within ±0.5 dB.

No. 3 ____ Use a windscreen if required when making measurements.

No. 4 ____ Take all readings on a path not blocked by trees, boulders, or other large objects.

No. 5 ____ Take several readings at an equal distance from the noise source. Draw a map that shows the noise source, and the location and the distance at which the readings were made.

FOR FURTHER STUDY

If you could not perform one or more of the five items above, review and practice the following lesson steps:

No. 1
Lesson Three, Step 4

No. 2
Lesson Three, Step 4

No. 3
Lesson Three, Step 5

No. 4
Lesson Three, Step 6

No. 5
Lesson Three, Step 6; Exercises 2-4.

REFERENCES

Peterson, Arnold P.G. and Erwin E. Gross, Jr. Handbook of Noise Measurement, 7th ed., Concord, MA, 1974.

U.S. Army, Academy of Health Sciences. Environmental Health Specialist Course, Segment Outline, "Calibration of Sound Measurement Instruments (Mimeo M74-350-947-3)," January 1977.

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